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COMMENTED VERSION

Oljefylld elektrisk utrustning – Provtagning på gas och olja för analys av fria och lösta gaser – Vägledning

*Oil-filled electrical equipment –
Sampling of gases and analysis of free and dissolved gases –
Guidance*

En så kallad ”Commented Version” (CMV) innehåller både den fastställda IEC-standardens och en kommenterad och ändringsmarkerad standard. Alla tillägg och borttagningar sedan den tidigare utgåvan är markerade med färg. Med en CMV sparar du mycket tid när du ska identifiera och förklara aktuella ändringar i standarden. SEK Svensk Elstandard kan bara ge ut CMV i de fall den finns tillgänglig från IEC.



IEC 60567

Edition 5.0 2023-12
COMMENTED VERSION

INTERNATIONAL STANDARD



Oil-filled electrical equipment – Sampling of free gases and analysis of free and dissolved gases in mineral oils and other insulating liquids – Guidance

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.040.10

ISBN 978-2-8322-7996-0

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CONTENTS

FOREWORD	5
INTRODUCTION	7
1 Scope	9
2 Normative references	9
3 Terms, definitions, symbols and abbreviated terms	10
3.1 Terms and definitions	10
3.2 Symbols and abbreviated terms	10
3.2.1 Symbols	10
3.2.2 Abbreviated terms	10
4 Sampling of gases from gas-collecting (Buchholz) relays	11
4.1 General remarks	11
4.2 Sampling of free gases by syringe	11
4.2.1 Sampling equipment	11
4.2.2 Sampling procedure	12
4.3 Sampling of free gases by displacement of oil	13
4.4 Sampling of free gases by vacuum	13
4.5 Sampling of oil from oil filled equipment	15
5 Labelling of gas samples	15
6 Sampling, labelling and transferring of oil from oil-filled equipment	16
6.1 Sampling and labelling of oil	16
6.2 Transfer of oil for DGA analysis	16
6.2.1 General	16
6.2.2 Transfer from oil syringes	16
6.2.3 Transfer from ampoules	16
6.2.4 Transfer from flexible metal bottles	17
6.2.5 Transfer from glass and rigid metal bottles	17
7 Preparation of gas-in-oil standards	17
7.1 General remarks	17
7.2 First method: preparation of a large volume of gas-in-oil standard	17
7.2.1 Equipment	17
7.2.2 Procedure	18
7.2.3 Calculation	20
7.3 Second method: preparation of gas-in-oil standards in a syringe or a vial	20
7.3.1 General	20
7.3.2 Equipment	22
7.3.3 Procedure	22
8 Extraction of gases from oil	22
8.1 General remarks	22
8.2 Multi-cycle vacuum extraction using Toepler pump apparatus	23
8.2.1 General	23
8.2.2 Toepler pump extraction apparatus	23
8.2.3 Extraction procedure	26
8.3 Vacuum extraction by partial degassing method	27
8.3.1 General remarks	27
8.3.2 Partial degassing apparatus	27
8.3.3 Extraction procedure	28

8.4	Stripping extraction method	28
8.4.1	General.....	28
8.4.2	Stripping apparatus	28
8.4.3	Outline of procedure	31
8.5	Headspace method.....	32
8.5.1	Principle of the method	32
8.5.2	Headspace extraction apparatus	33
8.5.3	Headspace extraction procedure.....	37
8.5.4	Calibration of the headspace extractor	41
9	Gas analysis by gas-solid chromatography	43
9.1	General remarks.....	43
9.2	Outline of suitable methods using Table 4	45
9.3	Apparatus.....	45
9.3.1	Gas chromatograph	45
9.3.2	Columns.....	47
9.3.3	Carrier gas	47
9.3.4	Detectors	47
9.3.5	Methanator.....	47
9.3.6	Cold trap.....	47
9.3.7	Integrator and recorder	47
9.4	Preparation of apparatus.....	48
9.5	Analysis	48
9.6	Calibration of the chromatograph	48
9.7	Calculations	49
10	Quality control	49
10.1	Verification of the entire analytical system	49
10.2	Limits of detection and quantification.....	50
10.3	Repeatability, reproducibility and accuracy	51
10.3.1	General remark	51
10.3.2	Repeatability	51
10.3.3	Reproducibility	51
10.3.4	Accuracy.....	52
11	Report of results	52
Annex A (informative) Correction for incomplete gas extraction in partial degassing method by calculation.....		54
Annex B (informative) Mercury-free and shake test versions of the standard extraction methods.....		
Annex B (informative) Alternative gas extraction methods.....		58
B.1	Mercury-free versions of the vacuum extraction methods	58
B.1.1	Mercury-free version of the Toepler method	58
B.1.2	Mercury-free version of the partial degassing method	58
B.2	Syringe versions of the headspace method.....	58
B.2.1	Shake test method.....	58
B.2.2	Mechanical oscillation method	60
Annex C (informative) Preparation of air-saturated standards		61
Annex D (informative) Correction for gas bubbles in syringes and air gap in rigid bottles		62
Annex E (informative) Procedure for comparing gas monitor readings to laboratory results		63

Annex F (normative) Insulating liquids based on synthetic and natural esters and silicones	64
Bibliography.....	66
List of comments.....	67
Figure 1 – Sampling of gas by syringe	12
Figure 2 – Sampling of free gases by oil displacement	13
Figure 3 – Sampling of free gases by vacuum	15
Figure 4 – First method of preparing gas-in-oil standards	19
Figure 5 – Second method for preparing gas-in-oil standards	21
Figure 6 – Example of a Toepler pump extraction apparatus.....	25
Figure 7 – Types of glass strippers	29
Figure 8 – Stainless steel stripper.....	30
Figure 9 – Schematic arrangement for connecting an oil stripper to a gas chromatograph.....	31
Figure 10 – Schematic representation of headspace sampler.....	32
Figure 11 – Vial filled with water	34
Figure 12 – Revolving table	36
Figure 13 – Schematic arrangement for gas chromatography.....	46
Figure B.1 – Schematic representation of methods in Annex B	59
Figure B.1 – Schematic representation of mercury-free Toepler method.....	59
Figure B.2 – Schematic representation of mercury-free partial degassing method	59
Figure B.3 – Schematic representation of shake test method.....	59
Figure B.4 – Schematic representations of mechanical oscillation method.....	60
Table 1 – Information required for gas samples.....	16
Table 2 – Examples of headspace operating conditions.....	37
Table 3 – Examples of headspace partition coefficients at 70 °C in mineral insulating oil.....	43
Table 4 – Examples of gas chromatographic operating conditions.....	44
Table 5 – Required limits of detection in oil.....	50
Table 6 – Examples of accuracy of extraction methods.....	52
Table A.1 – Examples of solubility coefficients a_i (at 25 °C) reported by CIGRE TF D1.01.15 in 2006	54
Table C.1 – Examples of solubility values of air for different oil types.....	61
Table C.2 – Examples of temperature variations for oxygen and nitrogen solubility in mineral oil.....	61

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**OIL-FILLED ELECTRICAL EQUIPMENT –
SAMPLING OF **FREE GASES AND ANALYSIS**
OF **FREE AND DISSOLVED GASES IN MINERAL OILS**
AND OTHER INSULATING LIQUIDS – GUIDANCE****FOREWORD**

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This commented version (CMV) of the official standard IEC 60567:2023 edition 5.0 allows the user to identify the changes made to the previous IEC 60567:2011 edition 4.0. Furthermore, comments from IEC TC 10 experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

IEC 60567 has been prepared by IEC technical committee 10: Fluids for electrotechnical applications. It is an International Standard.

This fifth edition cancels and replaces the fourth edition published in 2011. This edition constitutes a technical revision. **1**

This edition includes the following significant technical changes with respect to the previous edition:

- a) a new normative Annex F relating to DGA analysis of insulating liquids other than mineral oils (esters and silicones) has been added;
- b) Clause 4 to Clause 11 and informative Annex A to Annex E remain devoted to mineral oils;
- c) two new mercury-free gas extraction methods are described in Annex B (low pressure vacuum extraction and mechanical oscillation).

The text of this International Standard is based on the following documents:

Draft	Report on voting
10/1207/FDIS	10/1211/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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INTRODUCTION

Gases ~~may~~ can be formed in oil-filled electrical equipment due to natural ageing but also, to a much greater extent, as a result of faults.

Operation with a fault ~~may~~ can seriously damage the equipment, and it is valuable to be able to detect the fault at an early stage of development.

Where a fault is not severe, the gases formed will normally dissolve in the oil, with a small proportion eventually diffusing from the liquid into any gas phase above it. Extracting dissolved gas from a sample of the oil and determining the amount and composition of this gas is a means of detecting such faults, and the type and severity of any fault ~~may~~ can often be inferred from the composition of the gas and the rate at which it is formed.

In the case of a sufficiently severe fault, free gas will pass through the oil and collect in the gas-collecting (Buchholz) relay if fitted; if necessary, this gas may be analysed to assist in determining the type of fault that has generated it. The composition of gases within the bubbles changes as they move through the oil towards the gas-collecting relay.

This can be put to good use, as information on the rate of gas production ~~may~~ can often be inferred by comparing the composition of the free gases collected with the concentrations remaining dissolved in the liquid.

The interpretation of the gas analyses is the subject of IEC 60599.

These techniques are valuable at all stages in the life of oil-filled equipment. During acceptance tests on transformers in the factory, comparison of gas-in-oil analyses before, during and after a heat run test can show if any hot-spots are present, and similarly analysis after dielectric testing can add to information regarding the presence of partial discharges or sparking. During operation in the field, the periodic removal of an oil sample and analysis of the gas content serve to monitor the condition of transformers and other oil-filled equipment.

The importance of these techniques has led to the preparation of this document, to the procedures used for the sampling, from oil-filled electrical equipment, of gases and oils containing gases, and for subsequent analysis.

NOTE Methods described in this document apply to insulating oils, since experience to date has been almost entirely with such oils. The methods ~~may~~ can also be applied to other insulating liquids, in some cases with modifications.

General caution, health, safety and environmental protection

WARNING – This document does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this document to establish appropriate health and safety practices and determine the applicability of regulatory limitations prior to use.

The insulating oils which are the subject of this document should be handled with due regard to personal hygiene. Direct contact with the eyes ~~may~~ can cause irritation. In the case of eye contact, irrigation with copious quantities of clean running water should be carried out and medical advice sought. Some of the tests specified in this document involve the use of processes that ~~could~~ can lead to a hazardous situation. Attention is drawn to the relevant standard for guidance.

Mercury presents an environmental and health hazard. Any spillage should immediately be removed and be properly disposed of. ~~Consult local regulations~~ Regulatory requirements for mercury use and handling can apply. Mercury-free methods may be requested in some countries.

Environment

WARNING – This document is applicable to insulating oils, chemicals and used sample containers.

Attention is drawn to the fact that, at the time of writing of this document, many insulating oils in service are known to be contaminated to some degree by polychlorinated biphenyls (PCBs). If this is the case, safety countermeasures should be taken to avoid risks to workers, the public and the environment during the life of the equipment, by strictly controlling spills and emissions. Disposal or decontamination of these oils ~~should be carried out strictly according to local regulations~~ can be subject to regulatory requirements. Every precaution should be taken to prevent the release of any type of insulating oil into the environment, including those partially biodegradable with time.

OIL-FILLED ELECTRICAL EQUIPMENT – SAMPLING OF FREE GASES AND ANALYSIS OF FREE AND DISSOLVED GASES IN MINERAL OILS AND OTHER INSULATING LIQUIDS – GUIDANCE

1 Scope

This document deals with the techniques for sampling free gases from gas-collecting relays from power transformers. Three methods of sampling free gases are described.

The techniques for sampling oil from oil-filled equipment such as power and instrument transformers, reactors, bushings, oil-filled cables and oil-filled tank-type capacitors are no longer covered by this document, but are instead described in IEC 60475:2011/2022, 4.2.

Before analysing the gases dissolved in oil, they are first extracted from the oil. Three basic methods are described, one using extraction by vacuum (Toepler and partial degassing), another by displacement of the dissolved gases by bubbling the carrier gas through the oil sample (stripping) and the last one by partition of gases between the oil sample and a small volume of the carrier gas (headspace). The gases are analysed quantitatively after extraction by gas chromatography; a method of analysis is described. Free gases from gas-collecting relays are analysed without preliminary treatment.

The preferred method for ensuring the performance of the gas extraction and analysis equipment, considered together as a single system, is to degas samples of oil prepared in the laboratory and containing known concentrations of gases ("gas-in-oil standards") and quantitatively analyse the gases extracted. Two methods of preparing gas-in-oil standards are described.

For daily calibration checks of the chromatograph, it is convenient to use a standard gas mixture containing a suitable known amount of each of the gas components to be in a similar ratio to the common ratios of the gases extracted from transformer oils.

The techniques described take account, on the one hand, of the problems peculiar to analyses associated with acceptance testing in the factory, where gas contents of oil are generally very low and, on the other hand, of the problems imposed by monitoring equipment in the field, where transport of samples ~~may~~ can be by un-pressurized air freight and where considerable differences in ambient temperature ~~may~~ can exist between the plant and the examining laboratory.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60296, *Fluids for electrotechnical applications – ~~Unused Mineral insulating oils for transformers and switchgear~~ Mineral insulating oils for electrical equipment*

IEC 60475:2011/2022, *Method of sampling insulating liquids*

~~IEC 60599, Mineral oil-impregnated electrical equipment in service – Guide to the interpretation of dissolved and free gases analysis~~

~~ISO 5725 (all parts), Accuracy (trueness and precision) of measurement methods and results~~

ISO 5725-1, Accuracy (trueness and precision) of measurement methods and results – Part 1:
General principles and definitions

~~ASTM D2780, Standard Test Method for Solubility of Fixed Gases in Liquids~~

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Oljefylld elektrisk utrustning – Provtagning på gas och olja för analys av fria och lösta gaser - Vägledning

*Oil-filled electrical equipment –
Sampling of gases and analysis of free and dissolved gases –
Guidance*

Som svensk standard gäller europastandarden EN IEC 60567:2024. Den svenska standarden innehåller den officiella engelska språkversionen av EN IEC 60567:2024.

Nationellt förord

Europastandarden EN IEC 60567:2024

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC 60567, Fifth edition, 2023 - Oil-filled electrical equipment – Sampling of gases and analysis of free and dissolved gases – Guidance**

utarbetad inom International Electrotechnical Commission, IEC.

Tidigare fastställd svensk standard SS-EN 60567, utg 3:2012 med eventuella tillägg, ändringar och rättelser gäller ej fr o m 2027-01-12.

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English Version

Oil-filled electrical equipment - Sampling of free gases and
analysis of free and dissolved gases in mineral oils and other
insulating liquids - Guidance
(IEC 60567:2023)

Matériels électriques immergés - Échantillonnage de gaz
libres et analyse des gaz libres et dissous dans les huiles
minérales et d'autres liquides isolants - Recommandations
(IEC 60567:2023)

Ölgefüllte elektrische Betriebsmittel - Probenahme von
freien Gasen und Analyse von freien und gelösten Gasen in
Mineralölen und anderen Isolierflüssigkeiten - Anleitung
(IEC 60567:2023)

This European Standard was approved by CENELEC on 2024-01-12. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 10/1207/FDIS, future edition 5 of IEC 60567, prepared by IEC/TC 10 "Fluids for electrotechnical applications" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60567:2024.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2024-10-12
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2027-01-12

This document supersedes EN 60567:2011 and all of its amendments and corrigenda (if any).

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Endorsement notice

The text of the International Standard IEC 60567:2023 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standard indicated:

IEC 60599 NOTE Approved as EN IEC 60599
ISO/IEC 17025 NOTE Approved as EN ISO/IEC 17025
ISO 3675 NOTE Approved as EN ISO 3675

Annex ZA
(normative)

**Normative references to international publications
with their corresponding European publications**

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NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60296	-	Fluids for electrotechnical applications - Mineral insulating oils for electrical equipment	EN IEC 60296	-
IEC 60475	2022	Method of sampling insulating liquids	EN IEC 60475	2022
ISO 5725-1	-	Accuracy (trueness and precision) of measurement methods and results - Part 1: General principles and definitions	-	-

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Oil-filled electrical equipment – Sampling of free gases and analysis of free and dissolved gases in mineral oils and other insulating liquids – Guidance

Matériels électriques immergés – Échantillonnage de gaz libres et analyse des gaz libres et dissous dans les huiles minérales et d'autres liquides isolants – Recommandations



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Electropedia - www.electropedia.org

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INTERNATIONAL STANDARD

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Oil-filled electrical equipment – Sampling of free gases and analysis of free and dissolved gases in mineral oils and other insulating liquids – Guidance

Matériels électriques immergés – Échantillonnage de gaz libres et analyse des gaz libres et dissous dans les huiles minérales et d'autres liquides isolants – Recommandations

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.040.10

ISBN 978-2-8322-7960-1

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CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	9
2 Normative references	9
3 Terms, definitions, symbols and abbreviated terms.....	10
3.1 Terms and definitions.....	10
3.2 Symbols and abbreviated terms	10
3.2.1 Symbols	10
3.2.2 Abbreviated terms	10
4 Sampling of gases from gas-collecting relays	11
4.1 General remarks	11
4.2 Sampling of free gases by syringe	11
4.2.1 Sampling equipment	11
4.2.2 Sampling procedure.....	12
4.3 Sampling of free gases by displacement of oil.....	13
4.4 Sampling of free gases by vacuum.....	13
4.5 Sampling of oil from oil filled equipment.....	15
5 Labelling of gas samples	15
6 Sampling, labelling and transferring of oil from oil-filled equipment.....	15
6.1 Sampling and labelling of oil	15
6.2 Transfer of oil for DGA analysis	15
6.2.1 General	15
6.2.2 Transfer from oil syringes	15
6.2.3 Transfer from ampoules.....	16
6.2.4 Transfer from flexible metal bottles	16
6.2.5 Transfer from glass and rigid metal bottles	16
7 Preparation of gas-in-oil standards	16
7.1 General remarks	16
7.2 First method: preparation of a large volume of gas-in-oil standard	16
7.2.1 Equipment	16
7.2.2 Procedure.....	17
7.2.3 Calculation	19
7.3 Second method: preparation of gas-in-oil standards in a syringe or a vial	19
7.3.1 General	19
7.3.2 Equipment	21
7.3.3 Procedure.....	21
8 Extraction of gases from oil	21
8.1 General remarks	21
8.2 Multi-cycle vacuum extraction using Toepler pump apparatus	22
8.2.1 General	22
8.2.2 Toepler pump extraction apparatus.....	22
8.2.3 Extraction procedure	25
8.3 Vacuum extraction by partial degassing method.....	26
8.3.1 General remarks	26
8.3.2 Partial degassing apparatus	26
8.3.3 Extraction procedure	27

8.4	Stripping extraction method	27
8.4.1	General	27
8.4.2	Stripping apparatus	27
8.4.3	Outline of procedure	30
8.5	Headspace method	31
8.5.1	Principle of the method	31
8.5.2	Headspace extraction apparatus	32
8.5.3	Headspace extraction procedure	36
8.5.4	Calibration of the headspace extractor	40
9	Gas analysis by gas-solid chromatography	42
9.1	General remarks	42
9.2	Outline of suitable methods using Table 4	44
9.3	Apparatus	44
9.3.1	Gas chromatograph	44
9.3.2	Columns	46
9.3.3	Carrier gas	46
9.3.4	Detectors	46
9.3.5	Methanator	46
9.3.6	Cold trap	46
9.3.7	Integrator and recorder	46
9.4	Preparation of apparatus	47
9.5	Analysis	47
9.6	Calibration of the chromatograph	47
9.7	Calculations	48
10	Quality control	48
10.1	Verification of the entire analytical system	48
10.2	Limits of detection and quantification	49
10.3	Repeatability, reproducibility and accuracy	50
10.3.1	General remark	50
10.3.2	Repeatability	50
10.3.3	Reproducibility	50
10.3.4	Accuracy	51
11	Report of results	51
Annex A (informative) Correction for incomplete gas extraction in partial degassing method by calculation		53
Annex B (informative) Alternative gas extraction methods		54
B.1	Mercury-free versions of the vacuum extraction methods	54
B.1.1	Mercury-free version of the Toepler method	54
B.1.2	Mercury-free version of the partial degassing method	54
B.2	Syringe versions of the headspace method	54
B.2.1	Shake test method	54
B.2.2	Mechanical oscillation method	56
Annex C (informative) Preparation of air-saturated standards		57
Annex D (informative) Correction for gas bubbles in syringes and air gap in rigid bottles		58
Annex E (informative) Procedure for comparing gas monitor readings to laboratory results		59
Annex F (normative) Insulating liquids based on synthetic and natural esters and silicones		60

Bibliography.....	62
Figure 1 – Sampling of gas by syringe	12
Figure 2 – Sampling of free gases by oil displacement.....	13
Figure 3 – Sampling of free gases by vacuum.....	14
Figure 4 – First method of preparing gas-in-oil standards.....	18
Figure 5 – Second method for preparing gas-in-oil standards.....	20
Figure 6 – Example of a Toepler pump extraction apparatus	24
Figure 7 – Types of glass strippers	28
Figure 8 – Stainless steel stripper	29
Figure 9 – Schematic arrangement for connecting an oil stripper to a gas chromatograph.....	30
Figure 10 – Schematic representation of headspace sampler.....	31
Figure 11 – Vial filled with water	33
Figure 12 – Revolving table	35
Figure 13 – Schematic arrangement for gas chromatography	45
Figure B.1 – Schematic representation of mercury-free Toepler method	55
Figure B.2 – Schematic representation of mercury-free partial degassing method	55
Figure B.3 – Schematic representation of shake test method	55
Figure B.4 – Schematic representations of mechanical oscillation method	56
Table 1 – Information required for gas samples	15
Table 2 – Examples of headspace operating conditions	36
Table 3 – Examples of headspace partition coefficients at 70 °C in mineral insulating oil	42
Table 4 – Examples of gas chromatographic operating conditions.....	43
Table 5 – Required limits of detection in oil.....	49
Table 6 – Examples of accuracy of extraction methods	51
Table A.1 – Examples of solubility coefficients α_i (at 25 °C) reported by CIGRE TF D1.01.15 in 2006	53
Table C.1 – Examples of solubility values of air for different oil types	57
Table C.2 – Examples of temperature variations for oxygen and nitrogen solubility in mineral oil.....	57

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**OIL-FILLED ELECTRICAL EQUIPMENT –
SAMPLING OF FREE GASES AND ANALYSIS
OF FREE AND DISSOLVED GASES IN MINERAL OILS
AND OTHER INSULATING LIQUIDS – GUIDANCE****FOREWORD**

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IEC 60567 has been prepared by IEC technical committee 10: Fluids for electrotechnical applications. It is an International Standard.

This fifth edition cancels and replaces the fourth edition published in 2011. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) a new normative Annex F relating to DGA analysis of insulating liquids other than mineral oils (esters and silicones) has been added;
- b) Clause 4 to Clause 11 and informative Annex A to Annex E remain devoted to mineral oils;

- c) two new mercury-free gas extraction methods are described in Annex B (low pressure vacuum extraction and mechanical oscillation).

The text of this International Standard is based on the following documents:

Draft	Report on voting
10/1207/FDIS	10/1211/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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INTRODUCTION

Gases can be formed in oil-filled electrical equipment due to natural ageing but also, to a much greater extent, as a result of faults.

Operation with a fault can seriously damage the equipment, and it is valuable to be able to detect the fault at an early stage of development.

Where a fault is not severe, the gases formed will normally dissolve in the oil, with a small proportion eventually diffusing from the liquid into any gas phase above it. Extracting dissolved gas from a sample of the oil and determining the amount and composition of this gas is a means of detecting such faults, and the type and severity of any fault can often be inferred from the composition of the gas and the rate at which it is formed.

In the case of a sufficiently severe fault, free gas will pass through the oil and collect in the gas-collecting (Buchholz) relay if fitted; if necessary, this gas may be analysed to assist in determining the type of fault that has generated it. The composition of gases within the bubbles changes as they move through the oil towards the gas-collecting relay.

This can be put to good use, as information on the rate of gas production can often be inferred by comparing the composition of the free gases collected with the concentrations remaining dissolved in the liquid.

The interpretation of the gas analyses is the subject of IEC 60599.

These techniques are valuable at all stages in the life of oil-filled equipment. During acceptance tests on transformers in the factory, comparison of gas-in-oil analyses before, during and after a heat run test can show if any hot-spots are present, and similarly analysis after dielectric testing can add to information regarding the presence of partial discharges or sparking. During operation in the field, the periodic removal of an oil sample and analysis of the gas content serve to monitor the condition of transformers and other oil-filled equipment.

The importance of these techniques has led to the preparation of this document, to the procedures used for the sampling, from oil-filled electrical equipment, of gases and oils containing gases, and for subsequent analysis.

NOTE Methods described in this document apply to insulating oils, since experience to date has been almost entirely with such oils. The methods can also be applied to other insulating liquids, in some cases with modifications.

General caution, health, safety and environmental protection

WARNING – This document does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this document to establish appropriate health and safety practices and determine the applicability of regulatory limitations prior to use.

The insulating oils which are the subject of this document should be handled with due regard to personal hygiene. Direct contact with the eyes can cause irritation. In the case of eye contact, irrigation with copious quantities of clean running water should be carried out and medical advice sought. Some of the tests specified in this document involve the use of processes that can lead to a hazardous situation. Attention is drawn to the relevant standard for guidance.

Mercury presents an environmental and health hazard. Any spillage should immediately be removed and be properly disposed of. Regulatory requirements for mercury use and handling can apply. Mercury-free methods may be requested in some countries.

Environment

WARNING – This document is applicable to insulating oils, chemicals and used sample containers.

Attention is drawn to the fact that, at the time of writing of this document, many insulating oils in service are known to be contaminated to some degree by polychlorinated biphenyls (PCBs). If this is the case, safety countermeasures should be taken to avoid risks to workers, the public and the environment during the life of the equipment, by strictly controlling spills and emissions. Disposal or decontamination of these oils can be subject to regulatory requirements. Every precaution should be taken to prevent the release of any type of insulating oil into the environment, including those partially biodegradable with time.

OIL-FILLED ELECTRICAL EQUIPMENT – SAMPLING OF FREE GASES AND ANALYSIS OF FREE AND DISSOLVED GASES IN MINERAL OILS AND OTHER INSULATING LIQUIDS – GUIDANCE

1 Scope

This document deals with the techniques for sampling free gases from gas-collecting relays from power transformers. Three methods of sampling free gases are described.

The techniques for sampling oil from oil-filled equipment such as power and instrument transformers, reactors, bushings, oil-filled cables and oil-filled tank-type capacitors are no longer covered by this document, but are instead described in IEC 60475:2022, 4.2.

Before analysing the gases dissolved in oil, they are first extracted from the oil. Three basic methods are described, one using extraction by vacuum (Toepler and partial degassing), another by displacement of the dissolved gases by bubbling the carrier gas through the oil sample (stripping) and the last one by partition of gases between the oil sample and a small volume of the carrier gas (headspace). The gases are analysed quantitatively after extraction by gas chromatography; a method of analysis is described. Free gases from gas-collecting relays are analysed without preliminary treatment.

The preferred method for ensuring the performance of the gas extraction and analysis equipment, considered together as a single system, is to degas samples of oil prepared in the laboratory and containing known concentrations of gases ("gas-in-oil standards") and quantitatively analyse the gases extracted. Two methods of preparing gas-in-oil standards are described.

For daily calibration checks of the chromatograph, it is convenient to use a standard gas mixture containing a suitable known amount of each of the gas components to be in a similar ratio to the common ratios of the gases extracted from transformer oils.

The techniques described take account, on the one hand, of the problems peculiar to analyses associated with acceptance testing in the factory, where gas contents of oil are generally very low and, on the other hand, of the problems imposed by monitoring equipment in the field, where transport of samples can be by un-pressurized air freight and where considerable differences in ambient temperature can exist between the plant and the examining laboratory.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60296, *Fluids for electrotechnical applications – Mineral insulating oils for electrical equipment*

IEC 60475:2022, *Method of sampling insulating liquids*

ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results – Part 1: General principles and definitions*